A Braun-Blanquet reclassification of the Bankenveld Grassland in the Lichtenburg area, south-western Transvaal

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The Bankenveld Grassland in the Lichtenburg area was reclassified using TWINSPAN classification and subsequently Braun-Blanquet procedures to refine these results. In two phytosociological tables, two Major Communities, six Communities and eight Variants are identified and described. This new classification can now be included in the comprehensive phytosociological and syntaxonomical synthesis of the western Transvaal Grassland.

Die Bankenveldgrasveld in die Lichtenburg omgewing is deur middel van TWINSPAN geherklassifiseer en daarna deur Braun-Blanquet prosedures verfyn. In die twee fitososiologiese tabelle word twee hoofplantgemeenskappe, ses plantgemeenskappe en agt variasies geïdentifiseer en beskryf. Die nuwe klassifikasie kan nou by die omvattende fitososiologiese en sintaksonomiese sintese van die Wes-Transvaalse grasveld ingesluit word.

Keywords: Association analysis, Braun-Blanquet procedures, Bankenveld, classification, Western Grassland Biome.

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Introduction

During the mid-sixties an ecological survey of the natural and semi-natural vegetation of the Highveld Agricultural Region of South Africa was undertaken by the Botanical Research Institute (Scheepers 1975; Morris 1973). As part of this survey, a quantitative, semi-detailed plant-ecological study of the highveld grassland of the Lichtenburg area was done by Morris (1973). At that time the only objective method used for classifying vegetation in South Africa, was the hierarchical Association Analysis technique of the Southampton–Canberra school (Williams & Lambert 1959, 1961; Lambert & Williams 1962). Association Analysis is based on the successive subdivision of vegetation samples into two groups according to the presence or absence of a single species. This monothetic-divisive technique is repeated a number of times in order to yield a hierarchy. The dividing species are those that have the maximum ability to separate one group of species from another, implying the maximum sum of chi-squared values with all other species (Kooij *et al.* 1991). Morris (1973) used this technique to classify 220 relevés from the Lichtenburg area to distinguish the main vegetation types. He then carried out a second analysis on 110 relevés to obtain more information on the Bankenveld, due to the importance of its natural vegetation. This enabled him to distinguish and describe ten groups (reduced to seven) in the Bankenveld Grassland (Morris 1973). These groups are:

Group 1	*Diheteropogon–Stipagrostis* Primary Bankenveld
Group 2	*Diheteropogon–Schizachyrium* Bankenveld
Group 3	*Chascanum–Eragrostis racemosa* Sandy Bankenveld
Group 4	*Chascanum–Anthephora pubescens* Sandy Bankenveld
Group 5	*Corchorus–Ursinia* Bankenveld of Disturbed Sites
Group 6	*Fingerhuthia–Oropetium* Bankenveld of Dolomite Sheets
Group 7	No name.

Group 2 was subdivided into four groups, thus, in total ten groups were identified.

Although these groups were ecologically interpretable, results of this classification are difficult to reconcile with the results of the Braun-Blanquet classifications presently used for the synthesis of the Grassland Biome. Furthermore, Coetzee and Werger (1975) reported that the polythetic Braun-Blanquet analysis of floristic data results in more reliable vegetation units than the results of the monothetic divisive association analysis (Kooij *et al.* 1991, 1992). The original data set of Morris (1973) consisted of total floristic composition with Braun-Blanquet cover-abundance values for all identified species. Thus, in order to include Morris's Bankenveld data in the synthesis of the western Transvaal grassland [Bezuidenhout *et al.* 1994(b)], the data were reclassified by means of Braun-Blanquet procedures (Westhoff & Van der Maarel 1978). Kooij *et al.* (1991, 1992) used this procedure successfully to contribute towards a synthesis of the vegetation from the north-western Orange Free State, and Du Preez and Scheepers (1993) applied it successfully in the Bethlehem area. In this report the Braun-Blanquet classification of the Bankenveld Grassland in the Lichtenburg area is presented.

Study area

The study area of Morris (1973) is bounded by latitudes 26°00′ and 26°20′ south and longitudes 25°54′ and 26°22′ east. This study area is situated in the north-northwestern part of the area where Bezuidenhout (1993) is currently preparing a comprehensive synthesis of the vegetation of the western Transvaal (Figure 1). The study area comprises approximately 177 000 ha. A detailed description of the physical environment was given by Morris (1973, 1976), and is not presented here. The Bankenveld within this area is generally situated on the dolomite and chert of the Chuniespoort Group (Transvaal Sequence). The rocks in the western part of the area are covered with a thin layer of aeolian sand. The area is generally known as Klipveld (Louw 1951).

Methods

The stratification of the study area by Morris (1973, 1976) was based on the Bankenveld and *Cymbopogon–Themeda* Grassland Land Systems (Mabbutt 1968), excluding all lands under cultivation or showing signs of past cultivation, as well as the town of Lichtenburg and the bed of the Harts River. Relevés were compiled in 220 stratified random sample plots. The cover-abundance for each

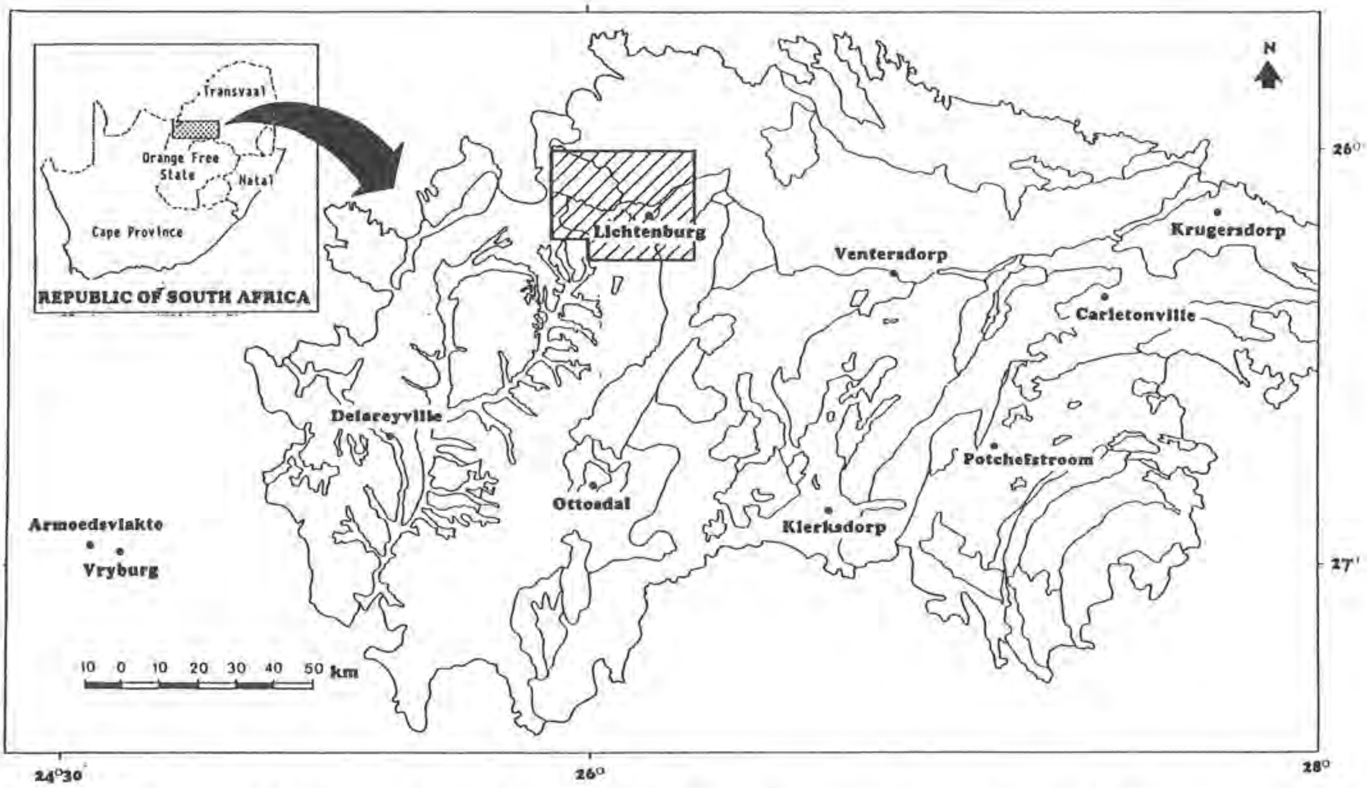


Figure 1 The location of the Morris study area (hatched) (Morris 1973) in the western Transvaal Grassland (Bezuidenhout, in prep.), South Africa.

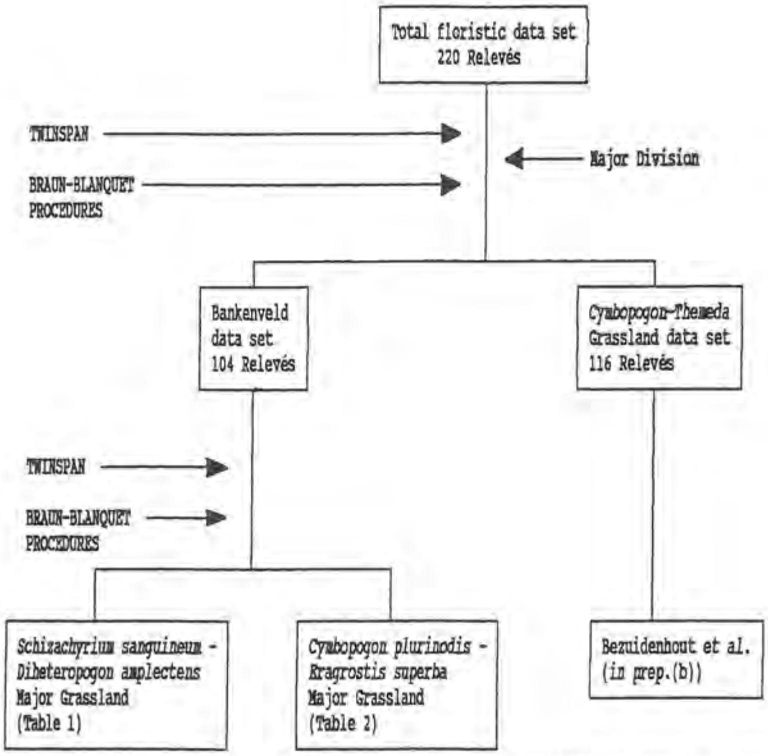


Figure 2 A dendogram to illustrate the major division of the total floristic data set (Morris 1973) as well as the division of the Bankenveld data set into two Major Grasslands.

species present in the sample plots was allocated according to the Braun-Blanquet scale (Braun-Blanquet 1932) and limited habitat information was noted in each sample plot of 16 m^2. More details are given by Morris (1973, 1976).

In the present study the classification algorithm TWINSPAN (Hill 1979) was used for analysing the total floristic data set (220 relevés), and subsequently Braun-Blanquet procedures were used to refine these results (Figure 2). The final phytosociological tables, plant community classification and descriptions are in Braun-Blanquet format (Tables 1 & 2). Amongst others these procedures were successfully used by Bezuidenhout (1988), Bezuidenhout *et al.* (1988), Behr and Bredenkamp (1988) and Bredenkamp *et al.* (1989).

Table 1 A phytosociological table of the *Schizachyrium sanguineum–Diheteropogon amplectens* Major Grassland from the Lichtenburg area

Sample plots	00000 44445 54896	00000000 46655568 67275946	00000000000 97589656657 71888830113	00000000000000 00099082845198 61539704172062	00000 26322 05185	0000000 2772531 2946408	000000 343337 432578	00100 54133 01086
Communities (in text)	1							
	1.1			1.2				1.3
	1.1.1	1.1.2	1.1.3	1.2.1	1.2.2	1.2.3	1.2.4	
Species group A								
Eragrostis racemosa	++++1	++++++++	++ ++++ ++	++ ++ ++++1 +	+ +	++ +++	+++ +	+1++
Schizachyrium sanguineum	22212	2+1+1+11	+1+11+1++11	+++++1 ++++++	+++ +	++	+ + +1	2+ +
Diheteropogon amplectens	12121	+++211+2	2+11+21+++	+11+ + 1 ++1++	+11	1 + 1	+	1 1+
Trachypogon spicatus	++121	211 1 2+	1+ + +1 ++	+ ++++ 2 +++	1 +	+	++++ +	+111+
Kyphocarpa angustifolia	++ +	++++	++ +++ +	+ + + ++++	++++	+ ++	+ ++	+ +
Oxygonum dregeanum	++	++++ ++	+++++++ ++	++ + + ++++	+	+ + +	++++ +	++++
Ophrestia oblongifolia	++ +	+++++	++ ++++++ +	++ + + +++++	++ +	+ +	+++++	+ ++
Dicoma anomala	+++++	++++++++	+++++++++++	+++ ++++++ ++	+++	+ ++++	++ +++	+++++
Species group B								
Loudetia simplex	+2++	2+3+++++	+ ++1+1++1+	+				
Bewsia biflora	+++++	++ ++++	+ +++ + +	+ +	+			
Urelytrum agropyroides	++	+ ++	+ +	+ +				
Species group C								
Rhynchosia nervosa	+	++++++++	+	+				
Silene undulata	+	++ + +	+	+				
Dianthus mooiensis		+ + +	+ +	+				
Cyperus sphaerospermus	++	++	+	+				+
Tribulus terrestris	++	++ +		+				
Species group D								
Anthephora pubescens		+	2 2	++ +++ 1++1	1+ 1	+ + 23+	++ +	
Indigofera daleoides	+			+ + ++++ +	+	+++ +++	+ +	+
Stipagrostis uniplumis				++1 +	113 2	++ 2121	2 +1	
Hermannia tomentosa				+++++ +	+ ++	+ ++++	+ +	
Setaria sphacelata			++	+ + +1+ ++	+ ++	++ ++++	3	
Eragrostis trichophora	+	+		++ + 1	+ 2+	2 +	+12211	+ +2
Cyperus marginatus	+		+ +	+ + +	+++	+++	+++ +	
Species group E								
Cyperus capensis			+	+ + ++++ +		+		
Tephrosia lupinifolia	+		+	+++ +				
Antizoma angustifolia	1			++ +	+			
Species group F								
Oropetium capense					++++	+		
Turbina oblongifolia				+ +	+++	+ +		
Species group G								
Fimbristylis hispidula							+ ++	
Eragrostis gummiflua				+	+	+	++ +	
Scilla nervosa						+	++ +	+
Walafrida saxitalis							++	
Digitaria argyrograpta		+		+ +	+	+	++	+
Species group H								
Eustachys paspaloides			+	+ + +	+ + 1	++1	+++ +	+
Cymbopogon plurinodis					+1+	+ + +	+ +	+
Eragrostis superba					+ +1	+ +	+++ +	
Cynodon dactylon			+		+	2	++++	
Eragrostis lehmanniana			+	+	+	1	+++1+	+

Table 1 Continued

Sample plots	00000 44445 54896	00000000 46655568 67275946	00000000000 97589656657 71888830113	00000000000000 00099082845198 61539704172062	00000 26322 05185	0000000 2772531 2946408	000000 343337 432578	00100 54133 01086
Communities (in text)	1							
	1.1			1.2				1.3
	1.1.1	1.1.2	1.1.3	1.2.1	1.2.2	1.2.3	1.2.4	
Species group I								
Andropogon appendiculatus							+ + +	1 ++
Sporobolus fimbriatus			+				+ 1+	+ +
Selago welwitschii				+ + +	+	+	+ +	+ ++
Species group J								
Talinum caffrum		+	+ +	++ + + +	+ +			
Polugala rehmannii	+		++ +	++ ++ +	+ +			+
Species group K								
Ipomoea obscura		+++	++++ + +	+++ + ++ ++	+++			
Chaetacanthus costatus	+	++ ++ ++	++++ +++	++ + + ++	+++ +	+	+	
Species group L								
Sporobolus pectinatus	+1++1	++++++++	++ +++++ +	+++ ++ ++ +	+		+	+ +
Andropogon schirensis	11 2	1 111	+11 + 1 1+	+1 ++ 1	+		1	
Tephrosia longipes	++++	++ ++	+ + +++	+ +++ + +	+			+
Species group M								
Senecio coronatus	+++	++++++	++++ ++++	+ ++ + + +	+ +			
Senecio venosus	+++ +	+++++++	++++ ++	+++ +++++++	+++ +	++ +		+
Thesium magalismontanum	+++++	+ ++++++	++++ ++	+++ + +	+++ +	+		+
Species group N								
Solanum supinum			+ ++ + +	++ + + +	+ +	+ +	+	
Corchorus asplenifolius			++ +	++ + + + +++	++++	++ + ++	+ ++1	++
Kohautia amatymbica	+	+	+ ++ +	++ + + ++ ++	++++	++++++	+++ +	+
Species group O								
Eragrostis stapfii	+	+ +	++ + +	+ +	++ +	+ +++ +	+ +	+
Ursinia nana		+ +	++ + +	+ +++ ++	+++	+ ++ +	+ +++	++
Triraphis andropogonoides	+	1 ++	12++1 ++	+ 11+++++ 1+++	12+++	2++++++	++2++1	++
Species group P								
Aristida congesta	1 +++	+++ ++	++++ 1+++++	+1 ++ ++++++++	+ ++1	+3+1+1+	+++1++	+++++
Themeda triandra	++1	+ +++ 1	1 ++ +	1+++1+12+1++ +	1 ++2	121+++2	+2+++1	+++ +
Anthospermum rigidum	+ +++	+ +++	+ ++++++	++++++++++++ +	+++++	+++++++	++++++	+++++
Elionurus muticus	++++	++++++++	++++ 2++ +	+++12+1+22++1+	11 +	12 ++ +	++++++	12++1
Brachiaria serrata	+++++	++ +++++	++++ +++++	+++++++++1++++	++1++	+++++++	++ + 1	+++++
Justicia anagalloides	+++++	+++++++	+++++++++++	++++++++++++++	+++++	++++ ++	+ +++1	+++++
Crabbea angustifolia	++ ++	++++ +	+++++++++	++++++++++ +++	+++++	+ +++++	+++ +	+ ++
Commelina africana	++++	++++++++	+ ++++++++	++++++ +++ ++	++	+ ++	++++++	++++
Helichrysum caespititium	+++++	++++++++	+++++++++++	++ ++++++++++	++ ++	++ +++	+ ++++	+++++
Diplachne fusca	+ +++	++++++++	+ ++ ++++++	++++ ++ +++++	+++	++ + 1+	++++++	++ ++
Pogonarthria squarrosa	++ +	+++ +++	1+ + +	+ + + +++	+++ +	1++++++	++ +++	+1
Chamaesyce inaequilatera	++	+ + +	+	+++++++++ ++	+++ +	+ +++++	+++ ++	+ +
Heteropogon contortus	+++++	1++ + 1	+1++ +++2 +	+ +++++1+ + 1	+ + +	++++1+1	++1+	+ +
Aristida diffusa	+++++	+ ++ 1	1121 +1+++1	+1+++++1+++ ++	1++	+++ +	+ ++	+++
Blepharis integrifolia	+ +	++ + + +	++ ++ + +	++++ ++++++++	++	+ ++ +	++++++	+ ++
Eragrostis curvula	++ +	+ ++1	++112+11+++	2+ 1 + 2+11	+++	+ ++ +	+ +	
Plexipus hederaceus	+++++	+++++	+++++++ + +	++++++++++++++	++ +	1+++++	+++ ++	++ ++
Bulbostylis burchellii	+++++	1+++++++	+++++++ ++	+++++++ +++++	++	+ +	+ ++	+++++
Barleria macrostegia	+ +	+ + +	+++++ + +	+++ ++ + ++	++	++ +++	+++	+
Nolletia ciliaris	+++++	+++ +++	+++++ + ++	++++ + ++++	++	+ +++++		++
Chamaecrista biensis	++ +	+ ++	+ + +++ ++	++ ++ +++ +	+++ +	+ + ++	+++ +	+ +
Cymbopogon excavatus	1+ 1	+++2 +	+ +1+ + 1	++++ 1 1	+1 1	+ ++	1+ +1	1111
Gazania krebsiana	+++	+++ +	+ +	+++++ ++	+ +	+++ + +	++ +	+ ++

Table 1 Continued

Sample plots	00000	00000000	00000000000	00000000000000	00000	0000000	000000	00100
	44445	46655568	97589656657	00099082845198	26322	2772531	343337	54133
	54896	67275946	71888830113	61539704172062	05185	2946408	432578	01086
Communities (in text)	1							
	1.1			1.2				1.3
	1.1.1	1.1.2	1.1.3	1.2.1	1.2.2	1.2.3	1.2.4	
Elephantorrhiza elephantina	+ ++	++ ++	+++ + ++	+ +	+	+	+ ++	+++
Raphionacme hirsuta	+	+ ++ +	+ +	++ + ++		+ +	+	+
Zornia milneana	+ +		+	++ ++++ +	+	++	+ ++	+
Lightfootia denticulata	+	++ ++	++ ++++	+ ++ +	+ +		++	++
Clematis brachiata	+	+	+ + + +	++ +	+	+ +		++
Geigeria burkei		+ +		+ +	+	++	+ +	+ +
Nidorella hottentotica		+ ++	+ +++	+			+	
Gnidia capitata	+	++ +	+++	+ + +++	+	+ + +		+
Melinis repens	++ +	+	+ ++	+ ++ + +	+ ++	+ +	+++++	+
Dicoma macrocephala	+ +		+	++++++++ +	+ ++	+ + ++		
Plexipus pinnatifidus				+ + +	+ ++	+ + +		
Lippia scaberrima		+		+ + ++	+ +	+	+ ++	+
Sida chrysantha			+ +	+ + + +			++ ++	+

Taxa names used in the plant community descriptions conform to those of Arnold and De Wet (1993). No attempt was made to formally fix names as this is normally avoided in detailed local studies (Coetzee 1983).

Topographical positions, adapted from Land Type Survey Staff (1984) and used in the descriptions, are crest, upper midslope and lower midslope.

A tabular comparison was made of the Bankenveld association analysis classification (Morris 1973) and the Bankenveld Braun-Blanquet classification (Table 3).

Results

The major division obtained by this procedure separates the total floristic data set (220 relevés) into the Bankenveld data set, consisting of 104 relevés, and *Cymbopogon–Themeda* Grassland data set, consisting of 116 relevés (Bezuidenhout *et al.*, in prep.) (Figure 2). Six relevés, which were originally classified as part of the Bankenveld Grassland (Morris 1973, 1976) are now classified in the *Cymbopogon–Themeda* Grassland. The Bankenveld is clearly represented by two Major Grassland communities which are presented in two separate phytosociological tables in this report (Tables 1 & 2).

A. Braun-Blanquet classification

The vegetation of the Bankenveld Grassland in the Lichtenburg area can be described as an *Elionurus muticus–Brachiaria serrata* Grassland. The most conspicuous feature of the vegetation of the Bankenveld Grassland on dolomite and chert is the complete absence of dominants (Louw 1951). A large number of species are represented but none succeeds in obtaining dominance. The relatively low cover of *Themeda triandra* is also not attributed to the grazing factor as is the case in the *Cymbopogon–Themeda* Grassland. This heterogeneous character of the vegetation is mainly determined by the physical nature of the soil (Louw 1951).

The Braun-Blanquet hierarchical classification of these plant communities is as follows:

1. *Schizachyrium sanguineum–Diheteropogon amplectens* Major Grassland (Table 1)
    - 1.1 *Loudetia simplex–Schizachyrium sanguineum* Grassland
        - 1.1.1 *Andropogon schirensis–Loudetia simplex* Variant
        - 1.1.2 *Rhynchosia nervosa–Loudetia simplex* Variant
        - 1.1.3 *Triraphis andropogonoides–Loudetia simplex* Variant
    - 1.2 *Anthephora pubescens–Schizachyrium sanguineum* Grassland
        - 1.2.1 *Elionurus muticus–Anthephora pubescens* Variant
        - 1.2.2 *Oropetium capense–Anthephora pubescens* Variant
        - 1.2.3 *Stipagrostis uniplumis–Anthephora pubescens* Variant
        - 1.2.4 *Eragrostis trichophora–Anthephora pubescens* Variant
    - 1.3 *Andropogon appendiculatus–Cymbopogon excavatus* Grassland
2. *Cymbopogon plurinodis–Eragrostis superba* Major Grassland (Table 2)
    - 2.1 *Fingerhuthia africana–Aristida diffusa* Grassland
    - 2.2 *Digitaria argyrograpta–Eragrostis lehmanniana* Grassland
    - 2.3 *Aristida congesta–Crassula transvaalensis* Grassland
        - 2.3.1 Variant

Description of the plant communities

1. *Schizachyrium sanguineum–Diheteropogon amplectens* Major Grassland

This Major Grassland is typically found on the relatively high-lying chert crests and upper midslopes in the Bankenveld Land System of the Lichtenburg area. It relates to Morris's groups 1, 2 and 3 (Table 3). The soil is heterogeneous and varies in depth (0.1–0.8 m), but is mostly considered as rocky and shallow. The diagnostic species are the perennial grasses *Eragrostis racemosa, Schizachyrium sanguineum, Diheteropogon amplectens* and *Trachypogon spicatus,* as well as the forbs *Oxygonum dregeanum, Kyphocarpa angustifolia, Ophrestia oblongifolia* and *Dicoma anomala* (species group A; Table 1). Typical of Bankenveld dolomite and chert, no species attains dominance, but the diagnostic grass species *Schizachyrium sanguineum, Diheteropogon amplectens* and *Trachypogon spicatus,* all indicators of shallow-

Table 2 A phytosociological table of the *Cymbopogon plurinodis–Eragrostis superba* Major Grassland from the Lichtenburg area.

Sample plots	1 1 1 880718218099078 496265143510977	1 1 4 1 03704 0419319632	1 1111922666023 5397573693793	997 1 42082
		2		
Communities (in text)	2.1	2.2	2.3	2.3.1
Species group A				
Cymbopogon plurinodis	+ +1+1++ + +	++1+1 +	+++ ++++1+2	+ +1
Eragrostis superba	1 ++1+1++1+	+ +++1+ ++	1 + 12++ ++	+ +
Sporobolus africanus	+ + + +++	+ 1+ +	+1 ++	++ +
Species group B				
Oropetium capense	++ 1+++++ + +	+ +	+ +	
Fingerhuthia africana	11 + +++ 1	+		
Tragus berteronianus	+ + ++ + +		+	
Cyperus margaritaceus	+ ++++++ ++	+	+	
Commelina benghalensis	++ + ++	+	+	
Lippia scaberrima	+ + + + +			+
Sida chrysantha	+ + + + +	+	+	+
Limeum viscosum	+ + ++	+	++	
Salvia radula	++ 1 +			
Raphionacme velutina	+ + + +			
Maytenus heterophylla	+ + + +			
Species group C				
Digitaria argyrograpta	+	++21+++		+
Cynodon dactylon	+ +	++ 113		
Species group D				
Plexipus hederaceus	+ +	+	++ ++ + +	+++
Crassula transvaalensis	+ +	+	++ + + + +	++
Blepharis angusta	+		++ + +	+
Guilleminea densa			+ +	++
Species group E				
Aristida diffusa	+11+ ++++22+++	+ ++	+ + +++	+
Diplachne fusca	+ ++ ++ + ++	++++	+ ++++ ++++	
Eragrostis lehmanniana	++1 + +++ ++	+ + 21+11	++ +	
Setaria sphacelata	+++ + ++	++ +	++ +++1+ 2	
Turbina oblongata	++ ++++++++ +	+ +++ ++	++ ++++ +++	+
Eragrostis trichophora	++ 1 +	++ + 1	1 + ++ +	
Bulbostylis burchellii	+++ + +	+ + ++	++++ + ++	
Cymbopogon excavatus	++ + + ++	1 1	+ + + +	
Species group F				
Aristida congesta	+++1+111+1++1++	++++++11+	++21++2++1212	1+1++
Stipagrostis uniplumis	112 +1+++212 ++	+ 1+ ++	1++++222311+	+ 111
Themeda triandra	+1+11+++1+11+	21++++21++	1+1 11121132	+1 1+
Triraphis andropogonoides	++ ++ +++++ ++	++++++	+1+ ++++++++	++ +
Anthephora pubescens	1 ++11+21 ++22+	21+ +++	+11+1+ 2+1+1	121+1
Elionurus muticus	++ 1++++11+	++ +++++	++ +++11 +	++
Pogonarthria squarrosa	+1+ +++ +++ +	1++ +	+++12++ ++++	++ ++
Eragrostis curvula	11 1 1++1+ 1	+ 1 +	+ ++ +	111+
Anthospermum rigidum	++ ++ ++++++	++ + +++++	++++++ +++	+++ +
Plexipus pinntifidus	++++++ ++ + +	++ +	++ ++++++++ ++	+++
Brachiaria serrata	+ ++ ++ +++2	++1 + +	++ +1 + +++	++++
Barleria macrostegia	++ ++ ++++	+++++ +	+++ + +++++++	+++++
Blepharis integrifolia	++ +++++ ++	+ ++	+++ + +	+++++
Corchorus asplenifolius	++ ++ +++++	+ + +	++++++ ++ +	+++++
Crabbea angustifolia	++ ++++ +++	+ + + +	+ + +++++++	+ +++
Commelina africana	+++++ +++++ +	+++ ++ ++	+ +++++++	++++
Eragrostis stapfii	++ +++ +++	+1+++++++	+++ ++ ++++	+ ++
Chamaesyce inaequilatera	+++++ ++++++ ++	+ + +++	+ +++++++	++++
Eustachys paspaloides	+ 1+++ + +++	+ +	++1 + ++ +1	+1+1
Hermannia tomentosa	++ ++++++++	+ ++ ++	++++++ + +	+++++
Heteropogon contortus	+ ++ + + ++	+ ++	++ +++ ++++	1 +
Chamaecrista biensis	+ ++++++ + +	+ + +	+ + ++	++ +
Indigofera daleoides	++ +++ ++ ++++	+++++ 1+	+++++ ++++++	+++++
Dicoma macrocephala	+ ++ ++ + +	+ +	++ ++++++	++++
Chaetacanthus costatus	+ +++ +	+ +	+ + ++ +	++
Helichrysum caespititium	+ + ++	+++ ++ +	++ + +++ +	++
Ipomoea obscura	+ + + + ++ +	+	+ +	+++ +
Justicia anagalloides	+ + + + +	+++ + ++	+++ + +++	+++++
Kohautia amatymbica	+ + + + +	+ + ++ +	+++++++ ++++	+++++
Solanum supinum	+ ++ ++ +	+ +	+++ ++ +	++
Ursinia nana	+ + +	+ ++ +	+2++ ++ +	+++
Vernonia oligocephala	++ ++ + +++ +	+ +	+ + + ++	+ ++
Nolletia ciliaris	++ + + ++	+ ++	+ +	+ ++
Elephantorrhiza elephantina	+ +	++	+ + +	
Raphionacme hirsuta	+ + +	+ +	+ + + +	+

rocky soils, have relatively high cover-abundance values.

This major high-lying Grassland is divided into three communities.

1.1 *Loudetia simplex–Schizachyrium sanguineum* Grassland

This community relates to group 2 of the Bankenveld Association Analysis (Morris 1973) (Table 3). With the exception of relevé 97 (group 3), all relevés are grouped in group 2 (Table 3). Morris (1973) gives a broad description of the habitat features of group 2 but not of the individual groups 2a, 2b, 2c and 2d.

The *Loudetia simplex–Schizachyrium sanguineum* Grassland is strongly associated with the chert crests and south- and north-facing upper slopes of the rises. The stony, very shallow (0.1–0.2 m) soil is normally littered with chert gravel on the soil surface. Outcrops of chert are present in this community.

The diagnostic species for the *Loudetia simplex–Schizachyrium sanguineum* Grassland are the perennial grasses *Loudetia simplex*, *Bewsia biflora* and *Urelytrum agropyroides* (species group B; Table 1). These species are typically restricted to very rocky and very shallow soils, while the diagnostic species of the *Schizachyrium sanguineum–Diheteropogon amplectens* Grassland, namely *Schizachyrium sanguineum*, *Diheteropogon amplectens* and *Trachypogon spicatus* are prominent due to high cover-abundance values.

Three variants of this community are identified in Table 1.

1.1.1 *Andropogon schirensis–Loudetia simplex* Variant

This Variant relates to group 2b (Morris 1973) (Table 3) and is concentrated in the eastern and central parts of the study area (Figure 1). It is associated with the microhabitat created by loose surface rocks, where the crests form plateaux. There are no diagnostic species for this Variant but the species from species groups A (diagnostic for *Schizachyrium sanguineum–Diheteropogon amplectens* Major Grassland), B (diagnostic for *Loudetia simplex–Schizachyrium sanguineum* Grassland), L, M and P (common species) are present in this Variant (Table 1), while species groups C and K are characteristically absent.

1.1.2 *Rhynchosia nervosa–Loudetia simplex* Variant

The *Rhynchosia nervosa–Loudetia simplex* Variant relates to groups 2b and 2c (Morris 1973) (Table 3). This Variant is found in shallow depressions on waning slopes. The diagnostic species from species group C (Table 1) are the forbs *Rhynchosia nervosa, Silene undulata, Dianthus mooiensis, Cyperus sphaerospermus* and *Tribulus terrestris*. Other species which are also present in this Variant are shown in Table 1.

1.1.3 *Triraphis andropogonoides–Loudetia simplex* Variant

The relevés of this Variant are scattered among groups 2a, 2b, 2c, 2d and 3 (Morris 1973) (Table 3). It occurs on the gentle waxing north- and south-facing slopes of the rises. No diagnostic species are present, but the Variant differs from the *Andropogon schirensis–Loudetia simplex* Variant in that species from species groups J, K, N and O (Table 1) are present.

1.2 *Anthephora pubescens – Schizachyrium sanguineum* Grassland

The *Anthephora pubescens–Schizachyrium sanguineum* Grassland is mostly found on the upper midslopes of the Bankenveld of the Lichtenburg area. Chert fragments and loose dolomite rocks are often found on the soil surface (Morris 1973). Although Morris (1973) mentioned a variety in soil depth, the soil of this Grassland is generally less rocky, deeper and more sandy than that of the *Loudetia simplex–Schizachyrium sanguineum* Grassland.

The diagnostic species for this community are the perennial grasses *Anthephora pubescens, Stipagrostis uniplumis, Setaria sphacelata* and *Eragrostis trichophora* while the perennial forbs *Indigofera daleoides, Hermannia tomentosa* and *Cyperus marginatus* are also diagnostic (species group D; Table 1). Most of these diagnostic species are associated with relatively deep sandy soils (Bezuidenhout *et al.* 1993; Bezuidenhout, in prep.). The wiry, sour grasses *Loudetia simplex* and *Uryletrum agropyroides*, diagnostic for the *Loudetia simplex–Schizachyrium sanguineum* Grassland, are absent, and *Schizachyrium sanguineum, Diheteropogon amplectens* and *Trachypogon spicatus* are less prominent. On the contrary, the more palatable grasses *Anthephora pubescens, Bustachys paspaloides, Themeda triandra* and *Elionurus muticus* are often conspicuously present, indicating a higher grazing potential of the vegetation on the deeper soils. Evidence of patch selection by livestock, and resulting overgrazing and degradation of the vegetation, is shown by the presence of pioneer species such as *Cynodon dactylon* and *Eragrostis lehmanniana*.

With the exception of the *Elionurus muticus–Anthephora pubescens* Variant (1.2.1), the rest of this community corresponds well with group 1 (Morris 1973) (Table 3).

Four Variants are identified in Table 1.

1.2.1 *Elionurus muticus–Anthephora pubescens* Variant

The relevés of this Variant are mainly scattered among groups 1, 2d and 3 (Morris 1973) (Table 3). Diagnostic species include *Antizoma angustifolia, Cyperus capensis* and *Tephrosia lupinifolia* (species group E; Table 1). The presence of species from species groups K, L and M (Table 1) indicate that this Variant has affinity to the more rocky *Loudetia simplex–Schizachyrium sanguineum* Grassland.

1.2.2 *Oropetium capense–Anthephora pubescens* Variant

This Variant is quite similar to group 1 (Morris 1973) (Table 3). Diagnostic species are *Oropetium capense* and *Turbina oblongifolia* (species group F; Table 1).

1.2.3 *Stipagrostis uniplumis–Anthephora pubescens* Variant

The relevés of this Variant are scattered among groups 1, 3 and 4 (Morris 1973) (Table 3). No diagnostic species were identified, but this Variant can easily be recognized by the absence of groups E, F, G and I (Table 1).

1.2.4 *Eragrostis trichophora–Anthephora pubescens* Variant

This Variant relates to groups 3 and 4 and to a lesser extent group 7 (Morris 1973) (Table 3). The Variant is characterized by species group G (Table 1) with the diagnostic species *Fimbristylis hispidula, Eragrostis gummiflua, Walafrida saxatilis, Scilla nervosa* and *Digitaria argyrograpta*.

Species group H indicates a close floristic relationship between communities 1.2.2, 1.2.3 and 1.2.4, and these communities are also typical representatives of the *Anthephora pubescens–Schizachyrium sanguineum* Grassland.

1.3 *Andropogon appendiculatus – Cymbopogon excavatus* Grassland

This community relates to no particular Association Analysis

Table 3: A comparison between the Bankenveld Association Analysis and Braun-Blanquet Bankenveld classification

Braun-Blanquet	Association Analysis										
classification	1	2a	2b	2c	2d	3	4	5	6	7	Total
1.1.1			5								5
1.1.2			5	3							8
1.1.3		2	2	2	4	1					11
1.2.1	4	1	1		4	4					14
1.2.2	3						1	1			5
1.2.3	3					2	2				7
1.2.4						3	2			1	6
1.3			1	1	1	1	1				5
2.1	1						2	1	7	4	15
2.2					1		1	2	1	5	10
2.3	1						7	5	1	4	18
Total	12	3	14	6	10	11	16	9	9	14	104

group and one relevé is classified in each of groups 2b, 2c, 2d, 3 and 4, indicating that this community was not recognized by Morris (1973, 1976) (Table 3). This vegetation is transitional to the *Cymbopogon plurinodis–Eragrostis superba* Major Grassland community (Community 2, Table 2). The vegetation is characterized by low species diversity, with only species groups A (diagnostic for *Schizachyrium sanguineum–Diheteropogon amplectens* Major Grassland), I and the widespread and general species of species group P (Table 1) present.

2. *Cymbopogon plurinodis–Eragrostis superba* Major Grassland

This Major Grassland community relates to groups 4, 5, 6 and 7 (Morris 1973) (Table 3). The *Cymbopogon plurinodis–Eragrostis superba* Major Grassland is situated on the lower midslopes of the Bankenveld Grassland in the Lichtenburg area. Due to the dolomite sheet outcrops which occur scattered throughout the area, the soil depth varies between very shallow (0.1–0.2 m) to moderately deep (0.5–0.8 m).

The diagnostic species for this community are the perennial grasses *Cymbopogon plurinodis, Eragrostis superba* and *Sporobolus africanus* (species group A; Table 2). Species typically found on the moderately deep sandy soils are *Stipagrostis uniplumis, Anthephora pubescens, Aristida diffusa* and *Eragrostis lehmanniana,* while *Themeda triandra, Brachiaria serrata* and *Eragrostis curvula* are prominently present. The relatively high cover-abundance of these species results in the relatively high grazing potential of this community.

2.1 *Fingerhuthia africana–Aristida diffusa* Grassland

The relevés of the *Fingerhuthia africana–Aristida diffusa* Grassland are scattered among groups 1, 4, 5 and 7, but the community relates best to group 6 (Morris 1973) (Table 3).

This Grassland community is found on extensive plains with stony, shallow (0.1–0.2 m) soils where dolomite sheets and outcrops cover the surface. This community is characterized by the diagnostic shrub *Maytenus heterophylla*, diagnostic perennial grasses *Fingerhuthia africana, Oropetium capense* and *Tragus berteronianus,* and the diagnostic forbs *Limeum viscosum, Salvia radula, Sida chrysantha, Raphionacme velutina, Senecio coronatus, Cyperus margaritaceus, Commelina benghalensis* and *Lippia scaberrima* (species group B; Table 2).

2.2 *Digitaria argyrograpta–Eragrostis lehmanniana* Grassland

This community is akin to, particularly, group 7, but some relevés were classified in groups 2d, 4, 5 and 6 (Morris 1973) (Table 3).

This community is situated on bare patches on the lower midslopes and sometimes outcrops of dolomite may occur. Two diagnostic species characterize this community, namely the perennial grasses *Digitaria argyrograpta* and *Cynodon dactylon* (species group C; Table 2).

2.3 *Aristida congesta–Crassula transvaalensis* Grassland

This Grassland community relates with group 4 but relevés also occur in groups 1, 5 and 7 (Morris 1973) (Table 3).

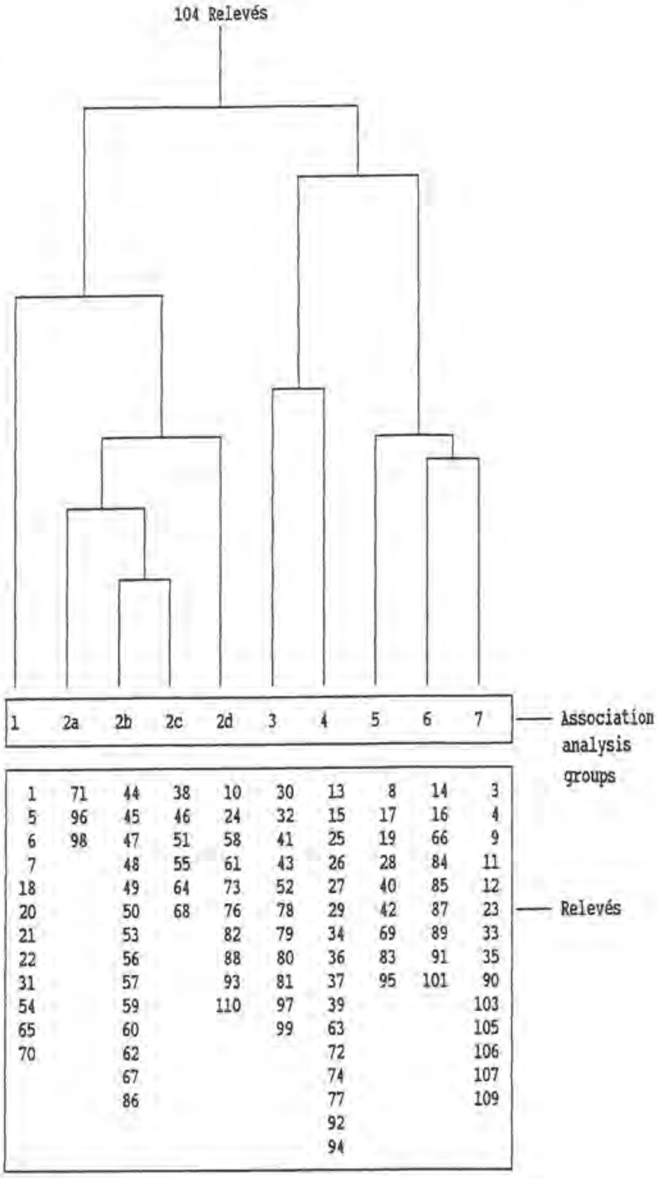
The *Aristida congesta–Crassula transvaalensis* Grassland is strongly associated with disturbed habitats, for example old diamond diggings, abandoned fields or heavily trampled or overgrazed areas. The habitat consists of some areas near diamond diggings, others on abandoned lands and the rest on heavily trampled and overgrazed vegetation. The soil is normally relatively deep (> 0.5 m).

The vegetation is characterized by species group D (Table 2) which includes the diagnostic inconspicuous forbs *Crassula transvaalensis, Plexipus hederaceus, Blepharis angusta* and *Guilleminea densa.*

Occasionally, where large sheets of rock are exposed, the soil is very shallow (0.1–0.2 m). Here, a Variant (2.3.1) of the community is recognized. This Variant is characterized by the absence of species group E. Species groups A, D and F are present in this Variant (Table 2), indicating a relatively low species diversity.

B. Comparison of Association Analysis and Braun-Blanquet classifications

The dendrogram produced by the Association Analysis of the vegetation (Morris 1973) is given in Figure 3. The allocation of relevés from the Association Analysis classification of the plant communities to the Braun-Blanquet analysis is given in Table 3. The general structure of this table broadly confirms the subdivision of the Bankenveld vegetation into two Major Grassland communities. Association Analysis groups 1–3 mainly represent



1	2a	2b	2c	2d	3	4	5	6	7
1	71	44	38	10	30	13	8	14	3
5	96	45	46	24	32	15	17	16	4
6	98	47	51	58	41	25	19	66	9
7		48	55	61	43	26	28	84	11
18		49	64	73	52	27	40	85	12
20		50	68	76	78	29	42	87	23
21		53		82	79	34	69	89	33
22		56		88	80	36	83	91	35
31		57		93	81	37	95	101	90
54		59		110	97	39			103
65		60			99	63			105
70		62				72			106
		67				74			107
		86				77			109
						92			
						94			

Figure 3 A dendrogram of the association analysis of the Bankenveld vegetation (Morris 1973) [six relevés excluded and added to *Cymbopogon–Themeda* Grassland data set (Bezuidenhout *et al.*, in prep.)].

the *Schizachyrium sanguineum–Diheteropogon amplectens* Major Grassland (Community 1, Table 1), while groups 4–7 mainly represent the *Cymbopogon plurinodis–Eragrostis superba* Major Grassland (Community 2, Table 2). The comparison between the Association Analysis and the Braun-Blanquet classification of the Bankenveld shows that 47 of the 104 relevés (45.19%) were classified in accordance with the Bankenveld Braun-Blanquet classification. This is due to the differences between the monothetic and polythetic divisions of the two approaches.

The results indicate that Association Analysis group 2b represents two easily recognizable and ecologically interpretable communities (1.1.1 and 1.1.2), while group 2d vaguely represents community 1.1.3. Groups 2a and 2c cannot be reconciled with any of the communities identified by the Braun-Blanquet procedures. On the other hand, group 1 is represented in three communities (1.2.1, 1.2.2 and 1.2.3), but community 1.2.1 is not recognized by the Association Analysis, as the relevés representing this community are scattered amongst five Association Analysis groups. Community 1.2.4 is mostly represented by relevés classified in group 3, but this group also contains relevés classified into other communities. Community 1.3 is not represented by any Association Analysis group. Communities 2.1 and 2.2 are mainly represented by groups 6 and 7, respectively, but community 2.3 mostly contains relevés from groups 4 and 5.

Conclusion

The data of Morris (1973, 1976) were successfully reclassified by Braun-Blanquet procedures. The plant communities identified and described coincide only partially with the previously described communities derived from the Association Analysis. This new classification can now be reconciled and compared with the other vegetation classifications of the Grassland Biome and can be included in the comprehensive phytosociological and syntaxonomical synthesis of the western Transvaal grassland.

It is interesting to note that these far-western Bankenveld communities show very little floristical relationship with the vegetation of the Fa land type on dolomite and chert to the east [Bezuidenhout *et al.* 1994(a)]. This is ascribed to the presence of the aeolian sand layer covering the soil in the north-western part of the western Transvaal grasslands.

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